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Joint Venture Formations in the Information Technology Sector:
A Diffusion-of-Innovation Perspective

N. Venkatraman and Jeongsuk Koh

Working Paper #3166-BPS
May, 1990

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Joint Venture Formations in the Information Technology Sector: A Diffusion-of-Innovation Perspective

Abstract

Based on a premise that insights from the study of the diffusion of technological innovations can be applied to the domain of administrative innovations, this paper examines the pattern of joint venture formation in an environment marked by high levels of environmental uncertainty. Viewing joint ventures as a class of administrative innovations, this paper tests the *imitation hypothesis* that the diffusion pattern can be described by an S-shaped curve. Data on joint venture formations over the period 1972-1988 in the information technology sector were subjected to empirical tests of the imitation hypothesis. The results did not support the imitation hypothesis, thus raising important theoretical issues on 'imitation versus strategic choice' and methodological issues on the potential role of diffusion models to study patterns of administrative innovations.

Key Words: Diffusion Models; Administrative Innovations; Joint Ventures; Information Technology Sector.

Introduction

Joint ventures (JVs) have emerged as an important administrative option for shaping and supporting corporate strategies in recent years. Indeed, it has been estimated that the number of joint ventures formed in the 1980's far exceed all the joint ventures formed in modern business history (Anderson, 1989). This concept is of importance to several constituencies and have been studied from different theoretical perspectives (see for instance, Harrigan, 1985; Hennert, 1988; Kogut, 1988a). The central research questions include: assessments of the motives for forming joint ventures (Berg & Friedman, 1977; Duncan, 1982; Hennart, 1988) and effectiveness of joint ventures (Harrigan, 1985; McConnell & Nantell, 1985).

This paper contributes to the stream of JV research through an additional theoretical and analytical lens, namely, the *diffusion-of-innovation* perspective. We adapt the general class of diffusion of innovation models (Rogers, 1983; Mahajan & Peterson, 1985) to the specific case of joint ventures as a particular class of administrative innovation. Building on prior research studies by Teece (1980) and Mahajan, Sharma and Bettis (1988) on the diffusion of the M-form organization as a class of administrative innovation, this study explores the role of diffusion models in understanding the pattern of JV formations. The underlying hypothesis is that within a business sector, JV as an administrative innovation is adopted by a group of innovators, whose strategic behavior influences nonadopters to adopt it, termed as the *imitation hypothesis* (see Mahajan et. al., 1988). Further, based on theoretical perspectives on competitive and mimetic isomorphism (DiMaggio & Powell, 1983), we argue that imitation is more likely when the business environment is marked by high levels of uncertainty. Accordingly we chose the information technology (I.T)¹ sector in the US to test our theory and hypotheses.

Theoretical Perspectives

We develop our theory as follows: First, we discuss diffusion models to set the context for arguing their possible relevance for examining the time-series pattern of JV formation. We next develop arguments supporting the consideration of JVs as a specific class of innovation, namely, administrative innovations. Finally, we argue that JV formation could be characterized by the specific functional form of the *imitation hypothesis*.

Diffusion-of-Innovation Perspective

The diffusion of an innovation is defined as the process by which it "is communicated through certain channels over time among the members of a social system" (Rogers, 1983: p. 5). Empirical studies have been concerned with developing analytical models to predict adoption patterns and the speed of the diffusion, where a dominant finding is that the cumulative adoption distribution can generally be described by an S-shaped curve with four important elements -- the innovation, channels of communication, time, and the social system (Mahajan & Peterson, 1985). The behavioral theory underlying the S-shaped nature of the diffusion process is that, as more firms that have adopted the innovation come into contact with nonadopting firms, their superior performance -- resulting from the earlier adoption of the particular innovation -- will encourage nonadopters to adopt the innovation. That is, the diffusion of innovation among the firms will be governed by the imitation of adopters by nonadopters, which is termed as the *imitation hypothesis*. More importantly, the rationale is that the nonadopters will realize the negative economic consequences of not adopting an innovation and take particular steps to adopt the innovation to neutralize the sources of competitive advantage that accrue to the innovator. As noted by Oster, "Successful strategies are prime targets of imitation, and imitation tends to equalize returns." (1990; page 91). Such a theoretical perspective has been adopted for the study of technological innovations

in general (Rogers, 1983; Mahajan & Peterson, 1985) as well as administrative innovations (Teece, 1980; Mahajan, Sharma, & Bettis, 1988). For an excellent, comprehensive review of the theoretical and analytical issues on the diffusion of innovation, see Mahajan, Muller and Bass (1990).

Joint Ventures as an Administrative Innovation

An interesting question pertains to the degree to which the innovation diffusion pattern that has been established for technological innovations applies to administrative innovations. Specifically, prior research has argued that the M-form organizational structure (i.e., divisional structure) be treated as an administrative innovation (e.g., Teece, 1980; Mahajan et. al., 1988). Extending this set of arguments, we propose that the formation of joint ventures (which is an organizational mechanism to shape and support corporate strategy) could be considered as an administrative innovation.

During the last decade, we have seen the emergence and acceleration of new forms of cooperative arrangements that are best viewed as falling between the classic market *versus* hierarchy continuum (Contractor and Lorange, 1988; Jarillo, 1988; Thorelli, 1986). Within this class of cooperative arrangements, joint ventures are the most visible and common mode (Contractor & Lorange, 1988), and can be argued as an administrative innovation to the extent that they are not perceived as a traditional governance mechanism in the market *versus* hierarchy dichotomy. Essentially, the argument that joint ventures are an administrative innovation stems from their economic rent-generating capacity which has been argued from various theoretical and empirical perspectives (Berg, Duncan & Friedman, 1982; Kogut, 1988a; Harrigan, 1985). Indeed, empirical research studies have demonstrated that the announcement of joint ventures, on average, have a significant impact on the market value of the participating parents (McConnell & Nantell, 1985).

Joint Venture Formation: An Imitation Hypothesis

The next line of theoretical reasoning relates to the specific functional form of diffusion. The most compelling functional form is the *imitation hypothesis* given the rationale rooted in the imitation of adopters by nonadopters (Mansfield, 1961; Mahajan et. al., 1990). Thus, the question is whether the preponderance of new forms of cooperative arrangements in recent years conforms to a *imitation hypothesis*. or is it explained by some other functional form. In environments marked by uncertainty due to factors such as technological discontinuity and obsolescence, there are strong pressures to develop technology-oriented cooperative ventures to be favorably positioned in the marketplace. As Nelson and Winter noted in their discussion of imitation as an organizational routine, "envious firms, then attempt to duplicate [the] imperfectly observed success " (1982; page 123), thus supporting the imitation hypothesis. More importantly, these ventures are undertaken as an insurance against possibly being locked-out of the emerging capabilities. Harrigan (1985) noted that, in 1983 alone, the number of cooperative arrangements announced in the communication systems and service industries exceeded the sum of all previously announced U.S. joint ventures in that sector, attesting to the growing importance of cooperative relationships. At a more general level, Miles and Snow (1986) view cooperative arrangements as an innovative organizational form that is both "cause and effect of today's competitive environment" (p. 62). Thus, there are a set of general conceptual arguments in favor of the imitation hypothesis. Such an argument can further be bolstered by arguments from the literature on competitive and institutional isomorphism.

Competitive and Institutional Isomorphism. The underlying behavioral theory is that the diffusion of an innovation among firms will be governed by the imitative behavior between adopters and nonadopters. Mansfield (1961) has documented that, as the number of firms adopting a given innovation increases,

competitive pressures mount resulting in significant 'bandwagon' effects. Although the efficiency-enhancing impact of adopting a particular JV cannot be easily estimated, the mere fact that a large number of its competitors are experimenting with this form of cooperative arrangement and that it appears to be positively viewed by the stock-market would prompt a firm to seriously consider its adoption. Chandler discusses the imitative behavior of M-form organization structure. According to him, "Once the new type of organization became known, as it did during the 1930's, its availability undoubtedly encouraged many enterprises to embark on a strategy of diversification, for the ability to maintain administrative control through such an organizational framework greatly reduced the risks of this new type of expansion (1962; page 394). In a similar vein, Schumpeter (1939) noted that accumulating experience and vanishing obstacles smooth the way for imitators; and Coleman, Katz, and Menzel (1966) noted a 'snowball' or 'chain-reaction' effect in their study of adoption of medical innovations.

This imitation behavior can be viewed as 'isomorphism,' which, in Hawley's (1968) view, is a constraining process that forces one business in a population to resemble others facing the same set of environmental conditions. As Meyer (1979) and Fennell (1980) argue, there are two types of isomorphism: *competitive* and *institutional*. Whereas competitive isomorphism is centered on a system rationality emphasizing market competition, institutional isomorphism stems from the view that "the major factors that organizations must take into account are other organizations" (Aldrich, 1979: p.265).

DiMaggio and Powell (1983) implicitly suggest that competitive isomorphism explains early adoption of innovations -- since early adopters are commonly driven by a desire to improve performance -- but that it may not present a comprehensive explanation of the diffusion pattern. Also, Meyer and Rowan (1977) contend that, as an innovation spreads, a threshold is reached beyond which adoption provides

'legitimacy' rather than improves performance. Innovations that are rational for individual firms may no longer be if adopted by large numbers; yet the very fact that they are normatively sanctioned increases the likelihood of their adoption.

The premise that an innovation confers upon adopters enhanced organizational efficiency, effectiveness, or both so that nonadopters have to bear significant disadvantages, may not sufficiently explain the imitative behavior. To better do so, the efficiency-enhancing nature of innovations, which triggers competitive isomorphism, must be supplemented by a mechanism through which institutional isomorphism occurs. It appears that 'mimetic' processes (DiMaggio and Powell, 1983) serve as a mechanism causing institutional isomorphism, which in turn contributes to the imitative behavior.

Mimetic isomorphism is essentially viewed as resulting from standard responses to uncertainty; which is a powerful force that encourages imitation. When organizational technologies are poorly understood, when goals are ambiguous, or when the environment creates symbolic uncertainty, organizations may model themselves on other organizations. The advantages of mimetic behavior in the economy of human action are considerable; when an organization faces a problem with ambiguous causes or unclear solutions, problemistic search may yield a viable solution with little expenses. [...]

[Thus], organizations tend to model themselves after similar organizations in their field that they perceive to be more legitimate or successful. The ubiquity of certain kinds of structural arrangements can more likely be credited to the universality of mimetic processes than to any concrete evidence that the adopted models enhance efficiency." (DiMaggio & Powell, 1983: pp. 151-152). The notion of mimetic processes, therefore, suggests that (other things being equal) the more uncertain the environment, the more rapidly an innovation will diffuse among firms. Further, the announcement of formations of joint ventures have been

received favorably by the stock market with significant, positive abnormal returns in general (McConnell & Nantell, 1985) as well as in the I.T. sector (Koh & Venkatraman, 1989). This reinforces the possibility of competitive isomorphism in the formation of joint ventures, supporting the imitation hypothesis.

Hence, we argue that the environmental factors (e.g., the rapid rate of technological change) play the critical role of amplifying the significance of joint ventures as an administrative innovation. Further, it is likely that competitive and mimetic isomorphism would govern the decision to form joint ventures in industries with high environmental uncertainty. The general research proposition, therefore, is:

Proposition: The diffusion of joint ventures among the firms would follow the imitation behavior in industries where environmental uncertainty [such as the rapid rate of technological change] is relatively high.

Rival Arguments

However, there are rival arguments against the imitation hypothesis that need to be recognized. Specifically, four sets of arguments are relevant: (a) instability; (b) knowledge-leakage; (c) causal ambiguity; and (d) firm-level strategic choice. First, some researchers have observed that the probability of joint venture success is low (e.g., Harrigan, 1985; Killing, 1982; Kogut, 1988b) despite positive reaction from the stock-market. The sources of instability include additional degrees of coordination among the partners, cultural differences that may not have been *a priori* recognized and other implementation bottlenecks which could decrease the stability of joint ventures. Further, there exists a possibility for either partners to behave opportunistically (Williamson, 1975) which enhances instability and act as a countervailing force against the imitation hypothesis.

A second argument relates to the possibility of leakage of proprietary knowledge and expertise, thus limiting the efficiency gains available through joint

ventures. For instance, in their investigation of joint ventures in developing countries, Beamish and Banks (1987) point that leakage can occur in one of two major ways: a local employee may decide to resign and use the knowledge acquired in the venture to establish a competing firm; or the local partner may decide to dissolve the venture and use the knowledge as a basis for continuing to serve the local market itself.

Third, unlike technological innovations, where the input-output relationship is reasonably well-known, the level of knowledge and understanding in designing and managing a joint venture may not be easy to duplicate. As Westney argued in her discussions of imitation and innovation in organizational emulation, “[P]erfect information about an organization model is never available to those engaged in creating a new organization, even when they have direct access to informants within the original model.” (1987; page 25) and that a “universal problem in constructing a new organization in emulation of a given model is that few of its members have any first-hand experience of how the original organization works.” (1987; p.26).

The final argument pertains to the strategic choice and discretion to adopt the governance mode that maximally exploits the available sources of competitive advantage. If we recognize that joint venture is one of the mechanisms available to achieve the corporate goals and objectives, then there are no strong reasons why every business should adopt the same governance mode. Indeed, the prevalent theory is that each firm should evaluate its set of strategic options with a view to *differentiate* from its competitors (Rumelt, 1979; Porter, 1980), thus under-emphasizing the possibility of imitation behavior. Further, based on Lippman and Rumelt (1982), we argue that the sources of value-creation from JVs may be complex, thus deterring routine imitation behavior. Given that the evaluation of appropriate governance mechanisms is a firm-specific choice, we may not observe

the pattern of imitation as in the case of technological innovation -- which may have more homogeneous application with limited variance in the range of potential benefits.

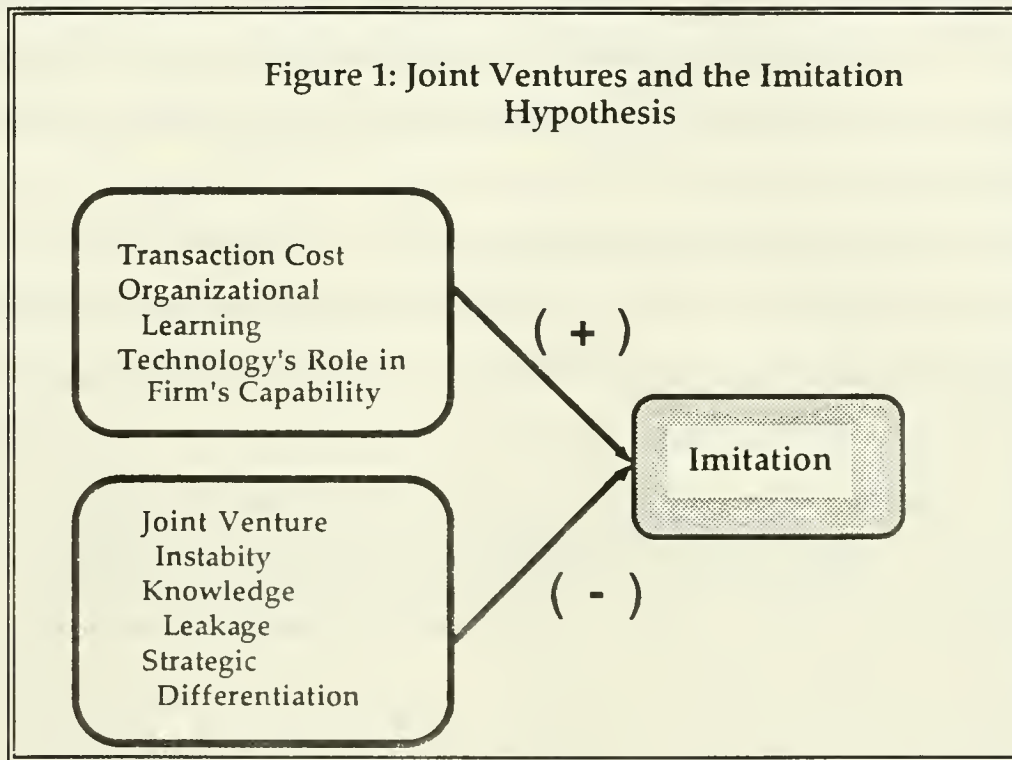


Figure 1 provides a schematic representation of the reasons supporting and opposing the theoretical perspectives that the pattern of JV formation in the I.T. sector can be represented in terms of an imitation hypothesis. The positive signs represent the forces favoring imitation, while the negative sign indicates forces opposing imitation. Thus, the general research proposition is worthy of empirical tests.

Methods

Sample Domain

Our specification of the sample domain was guided by the following considerations: (a) consistent with the proposition, we selected one sector characterized by high levels of environmental uncertainty, namely: the information technology sector; (b) since the imitation hypotheses may not hold true in

heterogeneous samples due to the complexity of communication channels operating to either enhance or inhibit imitation (Mahajan et. al, 1988), it is important to delineate a homogeneous sample frame; thus, even within the so-called IT sector, we define subclasses such as: (i) computer and computer peripheral equipment; (ii) telecommunications equipment; (iii) communication services, and (iv) cable television (CATV) services -- and test the hypotheses for each subclasses; and (c) since this paper is part of a larger study that sought to assess the effectiveness of JVs, we required that at least one of the parent firms be listed in the *Center for Research in Security Prices* (CRSP) files².

The time-series data for the formation of joint ventures were derived for the period -- 1972-1988. The adoption data on the parent firms listed in the CRSP file were developed by noting the year a firm announced the formation of a joint venture for the first time over the period between 1972 and 1988. For each year, the pooled data for the entire information technology sector [and the data for each of the four subsectors represent the number of parent firms that formed joint ventures for the first time] is shown in Table 1.

Analytical Methodology

The analytical methodology followed Mahajan et al. (1988) and consisted of: (a) selecting the diffusion models serving as the imitation hypothesis (i.e., alternative hypothesis) and the null hypothesis; (b) deriving the regression analogues of the selected models in order to delineate analytical formulations for the hypotheses which are appropriate for the test using the time-series data; and (c) evaluating the hypotheses by using the F-test statistic.

Alternative Diffusion Models for the Imitation Hypothesis

Mahajan and Peterson (1985) categorized the various models into the *fundamental diffusion* and *flexible diffusion* models. For the sake of simplicity and given the exploratory nature of the study, the models representing the imitation

hypothesis are selected from the fundamental diffusion models. These are typically categorized into three types: external-, internal-, and mixed- influence models.

External-Influence Models. The diffusion process in this type of models is generally hypothesized as being driven only by information from a communication source external to the social system (Coleman et al., 1966). Thus, the specification of the model is based on the assumption that the rate of diffusion at time t is dependent only on the potential number of adopters present in the social system at time t . In other words, the model does not attribute any diffusion to interaction between prior adopters and potential adopters and thus it does not recognize the imitation process. The most popular model in this category is the *Coleman model* which results in a modified exponential diffusion curve with a negative exponent. That is, over time the cumulative number of adopters increases at a decreasing (constant) rate.

The applicability of the Coleman model is best seen in the study of Hamblin, Jacobsen, and Miller (1973), which analyzed the incidence of labor strikes and political assassinations in 64 developing countries over twenty years. Since countries were geographically separated and the events were temporally separated, there was little communication or interaction among the strikers or assassins. Instead, the mass media were the only common channels of communication. In general, the external-influence model is best specified when the members are isolated or when adequate information on the complex innovation is only available from sources external to the social system -- such as government agencies or salespersons. This model can be considered for to organizational, administrative innovations in those cases where firms in an emerging industry adopt administrative strategies that have been successful in other, more mature industries. Given the relative infancy of information technologies, we argue that firms in the I.T. sector are likely to adopt administrative mechanisms that have

been successfully exploited elsewhere, thus supporting the consideration of external-influence model.

Internal-Influence Model. Whereas the external-influence model is grounded in the assumption that there is no interpersonal communication among social-system members, the internal-influence model is based on a premise that the diffusion occurs only through interpersonal contacts. For example, Coleman et al. (1966), in their study of the diffusion of gammanym, demonstrated that while gammanym adoptions, for 'integrated' physicians who acted as communities, could be described by an S-shaped curve, gammanym adoptions by 'isolated' physicians could be described by a modified exponential curve with a constant exponent, i.e., an external-influence model.

The rate of diffusion in the internal-influence model is considered solely as a function of interaction between prior adopters and potential adopters in the social system (e.g., Mansfield, 1961). Thus, the internal-influence model is most appropriate 'when an innovation is complex and socially visible, not adopting it places social system members at a disadvantage, the social system is relatively small and homogeneous, and there is a need for experiential or legitimizing information prior to adoption' (Mahajan & Peterson, 1985: p.18). This model could be justified in the present context on the grounds that there is a significant 'close-knit community' of technologists, venture capitalists and managers within the overall I.T. sector, thus enhancing internal communication as well as accelerating imitative behavior.

Mixed-Influence Model. This subsumes both the previous models by accommodating their assumptions (e.g., Bass, 1969). Thus, it is the most general form and widely used because seldom can the assumptions of either the external- or the internal- influence models be met unequivocally. Since the set of firms operating in the general I.T. sector are characterized by 'close-knit' community as

well as early stages of business life cycles, neither 'pure' models may apply perfectly, thus requiring the specification of a mixed-influence model.

The Null Hypothesis

Based on the above discussion, we could posit the external-influence model as the null hypothesis with the internal-influence model as the alternate hypothesis. However, following Mahajan et al. (1988), a stringent null hypothesis is one that posits that the formation pattern follows a white-noise or random walk process. This specifies that the difference between the numbers of adopters at t and $[t-1]$ is random, implying that the rate of diffusion will be driven by the error term only.

The mathematical form of the null hypothesis posits that the first differences in the noncumulative adoption time-series are random.

$$\begin{aligned}x(t) - x(t-1) &= \varepsilon(t); \text{ or} \\x(t) &= x(t-1) + \varepsilon(t)\end{aligned}\tag{1}$$

where $x(t)$ = the number of adopters at time t and the residuals, $\varepsilon(t)$, have a zero mean and $\varepsilon(t)$ is uncorrelated with $\varepsilon(t-k)$ for all nonzero k . The equation (1) specifies that the adoption time-series will proceed by a sequence of unconnected steps, starting each time from the previous value of the adoption time-series.

Coleman Model as an Alternative Hypothesis

Many attribute the increasing trend to adopt cooperative arrangements rather than going-it-alone to the growing ambiguity and uncertainty perceived in the economic environment as a whole (e.g., Harrigan, 1985; Kogut, 1988b; Miles & Snow, 1986). Implicit in this argument is that the propensity to cooperate has continuously increased over time regardless of what industry they compete in, reflecting the growing uncertainty associated with the general economic environment³.

This assertion allows the conjecture that a firm's decision to form a joint venture in an industry might be influenced not only by competitive pressure imposed by those firms that have already formed joint ventures in that industry (as the imitation hypothesis suggests), but also by the growing uncertainty prevailing in the general economic environment. For instance, the economic climate in the entire I.T. sector may affect the diffusion of joint ventures in the computer and computer peripherals subsector. Alternatively, the general pattern of JV formation in the USA or the developed economy may influence the activity in a particular industry. This is particularly relevant and important given the increased interdependence among businesses on a global basis.

Thus, to the extent that the general economic climate outweighs the internal influence, the diffusion pattern of joint ventures in that industry can be better explained by the external-influence model. Thus, in order to provide a robust test of the imitation hypothesis, we position the *Coleman model* (Coleman et al., 1966), a representative external-influence model as an alternative hypothesis.

The Coleman model is stated as:

$$dN(t)/dt = \pi(m - N(t)) \quad (2)$$

where $N(t)$ is the cumulative number of adopters at time t , m is the total number of adopters who will eventually adopt the innovation, π is a nonnegative constant and is usually defined as the coefficient of *external* influence, and $dN(t)/dt$ represents the rate of diffusion at time t . Thus, the rate of diffusion at time t is dependent only on the potential number of adopters in the social system at time t .

Following Mahajan et al. (1988), the regression analogue of the Coleman model can be stated as:

$$x(t) = \beta_1 x(t - 1) + e(t) \quad (3)$$

where $\beta_1 = 1 - p$ and $\beta_1 < 1$. It is important to note that the discrete version of the Coleman model, equation (3), generates the white-noise model when $\beta_1 = 1$.

Imitation Hypothesis

Two popular diffusion models that generate the S-shaped adoption pattern and capture the imitation behavior are those suggested by Mansfield (1961) and Bass (1969).

Following the same notations, the Bass model, a mixed-influence diffusion model, can be mathematically stated as:

$$dN(t)/dt = p(m - N(t)) + q/m(m - N(t))N(t) \quad (4)$$

where the nonnegative constants, p and q (for a successful innovation $q \gg p$), are defined as the coefficient of innovation and the coefficient of imitation, respectively. The first term in equation (4) reflects external influence; the second represents the contact between adopters and nonadopters, i.e., imitation or internal influence. The Mansfield model, an internal-influence diffusion model, assumes a pure imitation-adoption process and can be stated by assuming $p = 0$ in equation (4).

Following Mahajan et al. (1988), the regression analogue is stated as:

$$x(t) = \beta_1 x(t-1) + \beta_2 N^*(t-1) + e(t), \quad (5)$$

where $b_1 = 1 + q - p$ for the Bass model and $b_1 = 1 + q$ for the Mansfield model and $b_1 > 1$, $\beta_2 = -q/m$ and $\beta_2 < 0$, and $N^*(t-1) = N^2(t-1) - N^2(t-2)$. It is important to note that when $\beta_1 = 1$ and $\beta_2 = 0$, equation (5) yields the white-noise model. Table 2 summarizes the null and the alternative models along with the expected values for the parameters.

Table 2: Summary of Model Specifications and Hypotheses

Model	Specifications	β_1	β_2
Bass/Mansfield	$X(t) = \beta_1 \cdot x(t-1) + \beta_2 N^*(t-1) + e(t)$	>1	<0
Coleman	$X(t) = \beta_1 \cdot X(t-1) + e(t)$	<1	--
White-Noise	$X(t) = X(t-1) + e(t)$	1	--

Results

The Entire Information Technology Sector as the Base Sample Domain

Table 3 presents the results for the entire I.T. sector. For the two alternative models, the signs and the values of the estimated parameters conform to the expected patterns hypothesized in Table 2. The t-values for the coefficient β_1 in the Bass/Mansfield and the Coleman models are significant at the 0.1 and 0.001 levels of significance, respectively. The t-value for the coefficient β_2 in the Bass/Mansfield model is not significant. Finally, the two regression models are significant at levels better than 0.01.

Table 3: Parameter Estimates & Fit Statistics for the Entire Sample

Model	β_1 (t-value)	β_2 (t-value)	Adj R^2 (p-value)	Mean Absolute Deviation
Bass/Mansfield	1.044 (1.964)	(-) 0.0032 (-0.595)	0.4375 (0.0061)	3.348
Coleman	0.6966 (4.198)	--	0.5095 (0.0008)	3.348
White-Noise	1	--	0.4377	3.625

Comparisons With the White-Noise Model

Model	Null Values	F-Value	p-Value
Bass/Mansfield	$\beta_1 = 1; \beta_2 = 0$	1.3159	0.3017
Coleman	$\beta_1 = 1$	3.3427	0.0875

In terms of adjusted R^2 and mean absolute deviation, the Bass/Mansfield and the Coleman models yield better fits than the White-noise model. However, according to the F-test, the Bass/Mansfield does not significantly differ from the white-noise model. Thus, the null hypothesis *cannot* be rejected for the formation of joint ventures in the I.T. sector.

However, it is important to note that the null hypothesis of the white-noise model can be rejected at the 0.1 level of significance when the Coleman model serves as an alternative hypothesis. Thus, it appears that the external-influence

model provides the best fit to the data. We can speculate that the overall economic climate fostering the propensity to adopt cooperative arrangements in general, and joint ventures, in particular may have a stronger effect on the adoption of joint ventures in the information technology sector than does the pattern of prior administrative innovations. However, it is important to test the robustness of this result further by examining the imitation hypothesis for each of the four subsamples: computer and computer peripheral equipment, telecommunications equipment, CATV services, and communication services before arriving at a final conclusion. Appendix 1 summarizes the results of the four subsample analyses.

Based on the analyses reported in Table 2 as well as in Appendix 1, we observe that the imitation hypothesis is *rejected* in the overall sample as well as in three out of the four subsectors. In the CATV subsector, although the imitation hypothesis was not rejected, it provided as good a fit as the external-influence model, thus exhibiting minimal support -- at best -- for the imitation hypothesis.

Discussion

Joint Venture Formation: Imitative Behavior or Strategic Choice?

The incidence of joint venture formation has increased dramatically in the last two decades, and have become an important strategic mechanisms for competing in the marketplace. In the wake of this rapid increase, an obvious question is whether this can be explained by any 'bandwagon' or imitation effect. As Mahajan and Peterson (1985; p.18) note, "The internal-influence [imitation] model is most appropriate when an innovation is complex...., and not adopting it places social system members at a 'disadvantage' (e.g., a competitive disadvantage in business), ... and there is need for experiential or legitimizing information prior to adoption." These conditions apply quite well to the JV activity in the recent decades. Thus, if it could be established that the formation of JVs follows an imitation behavior pattern, it raises serious theoretical and managerial questions regarding

their relevance and importance in strategic management as well as question their value-enhancing role. On the other hand, if the imitation hypothesis is rejected, then their role is less explained by macro-processes, but by micro-processes at the level of the individual parents forming the particular joint ventures. Consequently, the proposition tested here is central to theory development as it is concerned with the issue of 'environmental determinism' versus 'strategic choice' in explaining organizational decisions (Van de Ven & Joyce, 1985).

Building from Teece (1988) and Mahajan et al. (1988) -- which tested the imitation hypothesis in the context of M-form organization structure, this study tested the hypothesis for another administrative innovation -- joint ventures, in one homogeneous industry sector. Our results strongly indicate that the diffusion of joint ventures in the I.T. sector does *not* correspond to the expected functional form, as we could not reject the null hypothesis. Moreover, this finding at an overall level *is stable* within three subsectors -- except for the CATV services segment, where it appears to be governed by imitation as well as external influence. Thus, while the studies on M-form hypothesis failed to support the imitation hypothesis, Mahajan et.al (1988) reported that their data best fits the white-noise (random) model. In contrast, in the case of JVs, we report strong support for the external-influence model.

A major reason for the absence of imitation behavior could be due to the 'uncertain imitability' concept advanced by Lippman and Rumelt (1982). Unlike technical innovation where the cost--performance relationships may be easily discerned, the role of a particular type of JV in adding value to a parent may be more complex and risky. Thus, while the increasing JV activity in the industry or the economy may induce strategic managers to recognize the possible role of JV as a strategic mechanism, it may not fully induce a firm to form a JV.

As many authors have claimed, it appears that in accordance with the growing uncertainty associated with the general economic environment, the propensity of strategic managers to cooperate as well as compete has continuously increased regardless of the industry settings (e.g., Miles & Snow, 1986; Jarillo, 1988; Thorelli, 1986). This could perhaps explain the strong results for the external-influence model rather than the internal-influence (imitation) model. We could perhaps speculate that it may be difficult to arrive at a macro-level explanation for the observed pattern of JV formation; and that each JV formation could be influenced by specific strategic considerations of product--market scope and distinctive competencies. Thus, the results are inconsistent with the institutional theories of organizational isomorphism in the context of this type of cooperative mechanism (DiMaggio & Powell, 1983) and leaves open the debate on the key driving forces of administrative innovations.

While our analytical approach cannot evaluate the relative superiority of competing theoretical perspectives, it appears that such a research strategy is promising. Specifically, the strong results for the external-influence model suggests that further theorizing is necessary to derive deeper understanding of the processes that influence the pattern of diffusion. In the classic, external-influence diffusion model, the coefficient of external influence signifies 'change agents' government agencies or some vertical channel in the marketplace (Mahajan & Peterson, 1985). Since such a general coefficient does not provide theoretical insights in the context of administrative innovations, a promising area of modeling is to derive an alternate functional form that represents the differential influence on the pattern of diffusion of administrative mechanisms. Such a refinement could contribute to a greater use of the diffusion models in strategic management, which is increasingly concerned with the relative roles of industry effects (i.e., deterministic) versus business strategic decisions (i.e., strategic choice) in explaining performance (see for

instance, Rumelt, 1988). Some promising approaches have been proposed in the marketing literature for incorporating marketing variables such as price, advertising and promotion in the study of diffusion of new products (see Mahajan et. al., 1990), which could be adapted to refine the specifications tailored to administrative innovations.

Extensions

Some major directions for extensions are noted to stimulate further work in this area:

Model Refinements. Since we framed the study as exploratory, we considered the fundamental diffusion models and chose the Bass/Mansfield specifications for the imitation hypothesis; this may be too simple to adequately describe the diffusion of JVs with multiple adoptions and dissolutions. Given the absence of imitation behavior and the strong influence of external factors, it is an opportune time to develop alternate paradigms on the growth patterns of administrative innovations that could build upon the work on technological innovations.

Replications. Given that the sample domain is to be homogeneous, we focused on one sector, namely the I.T. sector. While we established internal stability of the results within this sector, it will be useful to replicate this type of research in other settings marked by high environmental uncertainty to corroborate the results. This is in the spirit of cumulative theory construction in social sciences. Further, we collected historical data covering 1972-1988, although some JVs could have been formed before. Given the difficulty associated with collecting data from the 1960s, we assumed that this would have a negligible impact; and replications should attempt to trace the entire history of an administrative innovation to minimize the error of mis-specification; and

Larger Conceptualization of Cooperative Ventures. It may be useful to specify the administrative innovation as a cooperative venture in a key area of operations

rather than treat JVs in isolation. This is because the separation of JVs from other types of cooperative arrangements (such as: technology licensing, marketing exchange, joint R&D, etc.) is artificial since these are alternative governance mechanisms (i.e., different from the traditional market versus hierarchy dichotomy) in the marketplace whose relative superiority may be context-specific (Williamson, 1975). Thus, the consideration of JV diffusion could produce a result that is different and perhaps biased from the specification of key cooperative arrangements.

Conclusions

This paper adopted a new theoretical and analytical perspective to the understanding of JV formation in an industrial sector marked by high environmental uncertainty. We began with the premise that the pattern of JV formation in the I.T. sector will be consistent with the imitation hypotheses and tested this proposition using data from 1972-1988. The results in the overall sample as well as in four relatively homogeneous areas indicate no support for the imitation hypothesis. However, the alternative hypothesis of external-influence seems to be consistent with the data, raising a set of important theoretical and methodological issues. Our conclusion is that this perspective is valuable to understand the formation of JVs because insights from the study of the diffusion of technological innovations could be applied to the domain of administrative innovations. However, the state-of-art in model specifications is in its infancy and more focused research that adapts the impressive developments in the classical diffusion models to the requirements of administrative innovations could contribute significantly to this stream of research.

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Table 1: Adoption of Joint Venture Ventures in the I.T. Sector

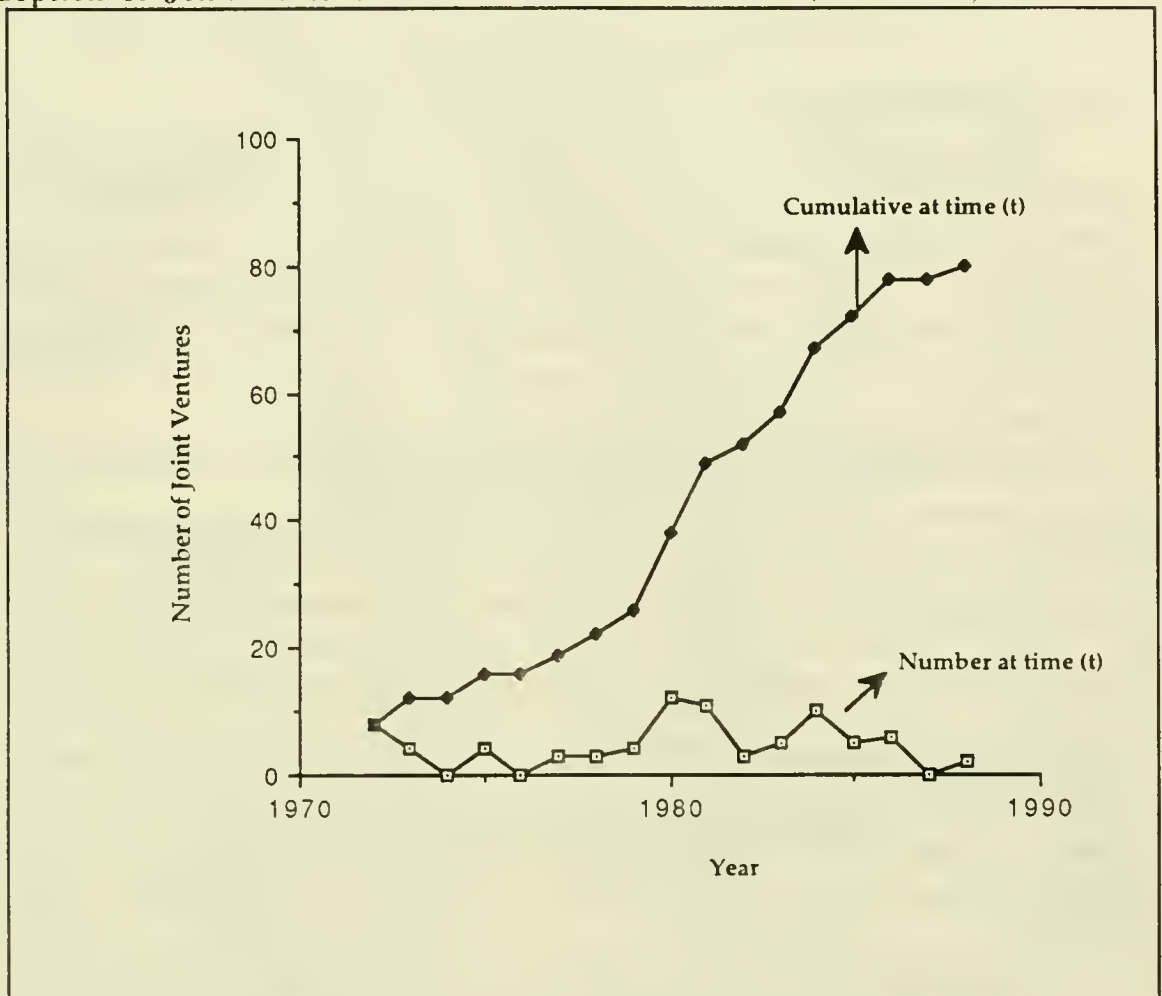
Number of Firms Forming Joint Ventures

Year	Sector		I		II		III		IV	
	x (t)	N (t)	x (t)	N (t)	x (t)	N (t)	x (t)	N (t)	x (t)	N (t)
72	8	8	2	2	2	2	3	3	1	1
73	4	12	2	4	2	4	0	3	0	1
74	0	12	0	4	0	4	0	3	0	1
75	4	16	1	5	0	4	0	3	3	4
76	0	16	0	5	0	4	0	3	0	4
77	3	19	0	5	3	7	0	3	0	4
78	3	22	2	7	0	7	2	5	0	4
79	4	26	2	9	0	7	2	7	0	4
80	12	38	3	12	5	12	3	10	3	7
81	11	49	0	12	0	12	11	21	0	7
82	3	52	0	12	2	14	2	23	2	9
83	5	57	3	15	0	14	0	23	7	16
84	10	67	3	18	2	16	0	23	10	26
85	5	72	1	19	3	19	1	24	2	28
86	6	78			3	22	2	26	2	30
87	0	78			0	22			0	30
88	2	80			1	23			2	32

KEY:

x (t)	Number of Adopters at t
N (t)	Cumulative Number of Adopters at t
Sector:	The Entire Information Technology Sector
I:	Computer & Computer Peripheral Equipment subsector
II:	Telecommunications Equipment subsector
III:	CATV Services subsector
IV:	Communications Services subsector

Adoption of Joint Venture Ventures in the I.T. Sector (Continued)



Appendix 1: Subsample Assessments in the Four Subsectors of the I.T. Sector

This appendix reports the results of four separate analyses carried out in the four subsectors to assess the robustness of the results.

Segment I: Computer and Computer Peripheral Equipment

Table A1 presents the results for the computer and computer peripheral equipment segment subsample. The signs and the values of the estimated parameters in the Bass/Mansfield model do not conform to the expected patterns, but the sign and the value of the estimated parameter in the Coleman model do conform to the expected patterns. Thus, the results for the Bass/Mansfield model do not provide support for the imitation hypothesis.

Table A1: Parameter Estimates and Model Comparisons for Computer & Computer Peripheral Equipment

Model	β_1 (t-value)	β_2 (t-value)	Adj R ² (p-val)	Mean Absolute Deviation
Bass/Mansfield	0.5121 (0.763)	.0017 .061	0.1927 (0.1378)	1.175
Coleman	0.5909 (2.682)	-- --	0.3226 (0.0200)	1.154
White-Noise	1	--	0.1951	1.154

Comparisons With the White-Noise Model

Model	Null Values	F-Value	p-Value
Coleman	$\beta_1 = 1$	3.4468	0.0881

The t-value for the coefficient β_1 in the Coleman model is significant at the 0.05 level of significance, and the overall model is significant at the same level. Although the Coleman model is not superior to the white-noise model in terms of mean absolute deviation, it yields a better fit in terms of adjusted R². According to the F-test, the null hypothesis can be rejected in favor of the Coleman model at the 0.1 level of significance. Thus, the results within this subsample is consistent with the overall result.

Segment II: Telecommunications Equipment

Table A2: Parameter Estimates and Model Comparisons for Telecommunications Equipment

Model	β_1 (t-value)	β_2 (t-value)	Adj R ² (p-val)	Mean Absolute Deviation
Bass/Mansfield	-0.2248 (-0.362)	0.0195 (0.812)	-0.0349 (0.4931)	1.345
Coleman	0.2794 (1.155)	--	0.0205 (0.2662)	1.452
White-Noise	1	--	-0.4615	1.813

Comparisons With the White-Noise Model

Model	Null Values	F-Value	p-Value
Coleman	$\beta_1 = 1$	8.8729	0.0094

As the wrong signs and values of the estimated parameters indicate in Table A2, the Bass/Mansfield model *does not* fit the data for the telecommunications equipment industry. Although the sign and value of the estimated β_1 in the Coleman model conform to the expected patterns, the Coleman model provides a poor fit for the data, as the fit statistics suggest. Despite its poor explanatory power, the Coleman model differs from the white-noise model at the 0.01 level of significance. Thus, the results for the subsector is consistent with the overall results.

Segment III: CATV Services

Table A3: Parameter Estimates and Model Comparisons for CATV Services

Model	β_1 (t-value)	β_2 (t-value)	Adj R ² (p-val)	Mean Absolute Deviation
Bass/Mansfield	3.1124 (3.194)	-0.0899 (-2.777)	0.4536 (0.0144)	1.499
Coleman	0.4408 (4.198)	--	0.1394 (0.0008)	1.609
White-Noise	1	--	-0.1224	1.929

Comparisons With the White-Noise Model

Model	Null Values	F-Value	p-Value
Bass/Mansfield	$\beta_1 = 1; \beta_2 = 0$	7.1235	0.0100
Coleman	$\beta_1 = 1$	5.2604	0.0391

For this subsample, the signs and the values of the estimated parameters conform to the expected patterns for both the Bass/Mansfield and the Coleman

models (Table A3). The t-values for the two coefficients in the Bass/Mansfield model are significant, and thus the model is significant at the 0.05 level. However, the Coleman model is marginally significant at the 0.1 level. In terms of adjusted R^2 and mean absolute deviation, the Bass/Mansfield model yields the best fit.

The F-test confirms that the Bass/Mansfield and the Coleman models are significantly different from the white-noise model at the 0.01 and 0.05 levels, respectively. Therefore both the Bass/Mansfield and the Coleman models provide a good explanation of the diffusion pattern of joint ventures in the CATV services industry. Thus, the diffusion of joint ventures in the CATV industry among the firms appears to exhibit imitation behavior as well as impacted by significant external influence.

Segment IV: Communication Services

Table A4: Parameter Estimates and Model Comparisons for Communications Services

Model	β_1 (t-value)	β_2 (t-value)	Adj R^2 (p-val)	Mean Absolute Deviation
Bass/Mansfield	0.9745 (2.036)	-0.0096 (-0.872)	0.2980 (0.0395)	2.172
Coleman	0.6000 (2.868)	--	0.3110 (0.0117)	1.988
White-Noise	1	--	0.1967	2.188

Comparisons With the White-Noise Model

Model	Null Values	F-Value	p-Value
Coleman	$\beta_1 = 1$	3.6548	0.0752

As shown in Table A4, since the value of the estimated β_1 in the Bass/Mansfield model does not conform to the expected pattern for the communication services sample, the model cannot be considered appropriate. On the other hand, the Coleman model's estimated parameter conforms to the expected pattern and is significant at the given level. Consistent with the computer and telecommunications equipment industries, the F-test indicates that the null hypothesis of the white-noise model can be rejected at the 0.1 level of significance in favor of the Coleman model.

Notes

¹ The term, information technology sector is used here to refer to a broad classes of products and markets that fundamentally use or based on technologies such as: computers, communication technologies, cable television and broadcasting.

² This consideration implies that those JVs formed with *neither* parent listed in the stock-exchange have not been included, perhaps marginally limiting the generalizability of results.

³For instance, a *Fortune* article (March 27, 1989) documented that: "In their quest for new markets and technology, U.S. corporations have formed over 2,000 alliances in the Eighties with European companies alone. Some joint-venturers assert that if you don't go abroad in these days of global markets, you will sooner or later get slaughtered at home. [...] Within a decade most companies will be members of teams that compete against each other. (pp. 66-67)".

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